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Short Note

Wood identification of some important timbers through chemical test

M. L. Pathak[1]*, R. Acharya[2], K. K. Pokharel[3] and D. Lamichhane[1]

Nepal is known as one of the richest countries for biodiversity, and almost all the climatic zones of the earth are represented within its national boundary (Hara and Williams*,* 1978; 1979). The World Conservation Monitoring Center have estimated that 6,500 species of angiosperms are found in Nepal (Caldecott *et al*., 1994; Bista *et al.,* 2001). Out of the estimated 6,500 flowering plants, approximately 1,000 species are trees. Nearly, 200 species attain tree size and are capable of producing timber (Bhargava and Kumar, 1977).

Wood is the cell-wall material produced by the cells of the cambium in a living tree. Wood cells make up the xylem portion of the tree as contrasted with the phloem (bark), which forms the protective outer layer. During the growing season, the cells of the cambium divide frequently into so called daughter cells which may differentiate into specialized elements of the phloem or the wood portion of tree trunk (Pandey, 2001). There are both inter and intra specific anatomical variation in plants (Noshiro *et al*., 1995). Changing of wood parameters along the elevational gradient was reported from some other studies too which can help to identify the wood at species-level (Pathak, *et al*., 2011, 2018).

Timber, the wood of commercial importance, is one of the most valuable and versatile raw materials used by people, and plays a vital role in the economic and industrial development of a nation. Timber identification is a highly specialized and fascinating field of study which is very complicated to even wood anatomist. Identification of timber may be grouped broadly into two heads, *viz*. general features and anatomical features. The former include common physical properties like color, weight, hardness, luster, etc. with the help of which simple carpenters and timber dealers also can identify the common timbers. The latter, on the other hand, can be studied only under the microscope and require a minimum basic knowledge regarding the structure of wood for their proper understanding and application in the field of identification of timbers (Pathak, 2012).

Botanical knowledge of important timber plants is necessary to identify them in their crude form when they are illegally traded, exported or smuggled. Those are either identified through anatomical study, DNA analysis, and staple isotope analysis or through chemical analysis. Chemical test is one of the general tools to confirm the wood of tree species. Some tools are made to identify the commercially important tree-wood through chemical test or even with the help of ultraviolet rays (BSI, 2012).

However, we need to be aware about the use of pesticides and flame retardants because of the chemical substances used. We should be equally aware that the wood sample is actually a solid piece of wood or a manmade composite or plastic made to imitate wood. In this study, we have tried to find out simple chemical reactions to identify some important timbers that are often brought to the National Herbarium and Plant Laboratories of the Department of Plant Resources (DPR) for their identification.

Materials and method

The wood powders of twenty four wood samples (triplicate samples of each tree) were made with

1. National Botanical Garden, Godawari-3, Lalitpur, Department of Plant Resources, Ministry of Forests and Environment, Nepal. *E-mail: scientistdrmitra@gmail.com
2. National Herbarium and Plant Laboratories Godawari, Department of Plant Resources, Ministry of Forests and Environment, Nepal
3. Forest Research and Training Centre, Ministry of Forests and Environment, Nepal

the help of a saw, and were mixed with water and different chemicals (Alcohol, Sulphuric Acid, Nitric Acid, Acetic Acid, Ether, Ammonia solution, Potassium Chlorate, Sprit, etc.). For the whole study, the BSI 2012 method was partially followed, and some innovative ideas were created. The chemical reactions of wood powder and chemical reagents were observed for twenty four hours. The results of the preliminary reactions were noted down instantly while the final results were obtained after twenty four hours. The study was accomplished during the lab experiment of wood samples at National herbarium and Plant Laboratories from 2011 to 2019.

Results and discussion

The results of the chemical tests of wood powders and different chemicals are presented in Tables 1−8. In the first phase of our study, only the color obtained from chemical reaction is presented. In the second phase, the chemical reactions and resulted compound with color will be studied in detail.

Out of the eight tree-timbers studied, only the wood-powder of *Dalbergia sisoo* reacted with water and dissolved slightly, and formed suspension at bottom initially yielding slightly pale yellow color after 24 hours. Similarly, the wood powder of *Pterocarpus santalinus* reacted with Ethyl Alcohol yielding red blood color both at initial and final stages. On the other hand, the wood powder of *Santalum album* reacted with Ethyl Alcohol yielding black suspension at bottom. The wood powders of the rest seven tree-timbers did not show any reaction with ethyl alcohol. On the contrary, the wood powders of *P. santalinus, P. marsupium, S. album, Acacia catechu, Dalbergia sisoo, D. latifolia, Shorea robusta* and *Terminalia alata* reacted with concentrated Sulphuric Acid yielding deep purplish black suspension or black color at the top initially and after 24 hours as well. Similarly, the wood powders of *P. santalinus* and *S. album* reacted with Conc. Nitric Acid yielding yellow color after 24 hours while the wood powder of *Accacia catechu* with Nitric Acid yielded pale yellowish color after 24 hours. Likewise, the wood powders of *A. catechu* and *S. album* with Conc. Nitric Acid yielded pale yellowish red color and yellow color, respectively with brown suspension at the top at the beginning and turned into green color after 24 hours. On the other hand, the wood powder of *P. marsupium* with Concentrated Nitric Acid yielded black suspension at the top initially and turned into green color after 24 hours. Similarly, the wood powders of *S. album* and *A. catechu* with Concentrated Nitric Acid yielded yellow color and pale yellowish color initially and pale yellowish red color after 24 hours. The wood powder of *P. santalinus* with Acetic Acid yielded deep red color initially and turned into deep orange red color after 24 hours. In the case of *S. album, A. catechu, P. marsupium, D. latifolia, S. robusta and T. alata*, the wood powders did not show any reaction with Acetic Acid. However, the wood powder of *Pterocarpus. santalinus* with Ammonia solution yielded violet color initially and later too while that of *Santalum album* yielded red color with suspension at the bottom. The wood powder of *Acacia catechu* with Ammonia solution yielded black color with suspension at the bottom. On the other hand, the wood powders of *P. marsupium* and *D. latifolia* with Ammonia solution did not show any reaction. However, the wood powder of *D. sissoo* with Ammonia solution yielded yellowish suspension at the bottom at the beginning and finally turned into violet color at the bottom. The wood powder of *S. robusta* with Ammonia solution remained intact at the bottom initially, and finally turned into violet color with suspension at the bottom.

For some genus, we tried to find out the possible chemical reactions between the wood powder and the chemical used; In the case of *Shorea robusta,* heartwood extractives (brown color) leaching out when in contact with water (Richter and Dallwitz, 2000). Likewise, the chemical 'santalin' ($C_{15}H_{14}O_5$) reacts with ethyl alcohol (C_2H_5OH) and yields red color (BSI, 2012). Nevertheless, the details of reactions among all wood powders (their chemical compounds) and studied reagents could not be traced out.

Table 1: ***Pterocarpus santalinus*** (Raktachandan**)**

S.N.	Activities	Initial result	Result after 24 hrs.
I	Wood Powder + Water (H_2O)	No reaction	No reaction
II	Wood Powder + Ethyl Alcohol	Soluble with red blood color	Red blood color
III	Wood Powder + Acetic Acid	Deep red	Deep orange red color
IV	Wood Powder + Conc. H_2SO_4	Insoluble with deep purplish black suspension at top	Insoluble with deep purplish black suspension at top
V	Wood Powder + Conc. HNO_3	No color	Yellow color after 24 hours
VI	Wood Powder + Ether	Soluble with yellow color	Soluble with yellow color
VII	Wood Powder + $KClO_3$	Purple color	Purple color
VIII	Wood Powder + NH_3	Soluble with violet color	Soluble with violet color

Table 2: ***Santalum album*** **(Shreekhanda)**

S.N.	Activities	Initial result	Result after 24 hrs.
I	Wood Powder + Water (H_2O)	No reaction	No reaction
II	Wood Powder + Conc. H_2SO_4	Dissolved with black color	Dissolved with black color
III	Wood Powder + Acetic Acid	No reaction	No reaction
IV	Wood Powder + Conc. HNO_3	Dissolved with yellow color	Dissolved with yellow color
V	Wood Powder + Ethyl Alcohol	Dissolved and makes black suspension	Dissolved with black suspension
VI	Wood Powder + NH_3	Red color with suspension	Red color with suspension

Table 3: ***Acacia catechu*** **(Khair)**

S.N.	Activities	Initial result	Result after 24 hrs.
I	Wood Powder + Water (H_2O)	No reaction	No reaction but suspension at bottom
II	Wood Powder + Ethyl Alcohol	No reaction	No reaction
III	Wood Powder + Acetic Acid	No reaction	No reaction
IV	Wood Powder + NH_3	Black color	Black suspension
V	Wood Powder + Conc. H_2SO_4	Black color	Black suspension
VI	Wood Powder + Conc. HNO_3	Pale yellowish color	Pale yellowish red color

Table 4: ***Pterocarpus marsupium*** **(Bijayasal)**

S.N.	Activities	Initial result	Result after 24 hrs.
I	Wood Powder + Water (H_2O)	No reaction	No reaction
II	Wood Powder + Ethyl Alcohol	No reaction	No reaction
III	Wood Powder + Acetic Acid	No reaction	No reaction
IV	Wood Powder + NH_3	Undissolved	Undissolved both at top and bottom
V	Wood Powder + Conc. H_2SO_4	Black suspension at top	Black suspension at top
VI	Wood Powder + Conc. HNO_3	Brown suspension at top	Color changed into green

Table 5: ***Dalbergia latifolia*** **(Satisal)**

S.N.	Activities	Initial result	Result after 24 hrs.
I	Wood Powder + Water (H_2O)	No reaction	No reaction
II	Wood Powder + Ethyl Alcohol	No reaction	No reaction
III	Wood Powder + Acetic Acid	No reaction	No reaction
IV	Wood Powder + NH_3	Undissolved	Undissolved both at top and bottom
V	Wood Powder + Conc. H_2SO_4	Black suspension at top	Black suspension at top
VI	Wood Powder + HNO_3	Undissolved	Orange color

Table 6: ***Dalbergia sisoo*** **(Sissoo)**

S.N.	Activities	Initial result	Result after 24 hrs.
I	Wood Powder + Water (H_2O)	Slightly dissolved with suspension at bottom	Slightly pale yellow color
II	Wood Powder + Ethyl alcohol	No reaction	No reaction
III	Wood Powder + NH_3	Yellowish suspension at bottom	Violet color at bottom
IV	Wood Powder + Conc. HNO_3	Dissolved with orange red color	Yellow suspension at bottom
V	Wood Powder + Acetic Acid	Not dissolve suspension at bottom	Slightly pale yellow suspension at bottom
VI	Wood Powder + Conc. H_2SO_4	Black suspension at top	Whole black suspension at bottom

Table 7: ***Shorea robusta*** **(Sal)**

S.N.	Activities	Initial results	Result after 24 hrs.
I	Wood Powder + H_2O (Water)	Undissolved with suspension at bottom	Brown suspension at bottom
II	Wood Powder + Ethyl Alcohol	Undissolved with suspension at bottom	Suspension at bottom
III	Wood Powder + NH_3	Remained same at bottom	Violet color suspension at bottom
IV	Wood Powder + HNO_3	Reddish brown suspension at top	Red black color suspension at bottom
V	Wood Powder + Acetic Acid	suspension at bottom	suspension at bottom
VI	Wood Powder + H_2SO_4	Black suspension at top	Whole black suspension
VII	Wood Powder + Spirit	Undissolved with suspension at bottom	Suspension at bottom

Table 8: ***Terminalia alata*** **(Asna/Saaj)**

S.N.	Activities	Initial results	Result after 24 hrs.
I	Wood Powder + Water (H_2O)	Undissolved with suspension at bottom	Suspension at bottom
II	Wood Powder + Alcohol	Undissolved with suspension at bottom	Suspension at bottom
III	Wood Powder + Acetic acid	Not dissolve remain at bottom	Suspension at bottom
IV	Wood Powder + NN_3	Suspension at bottom	Changes into violet color
V	Wood Powder + H_2SO_4	Black suspension at top	Black suspension both at top and bottom
VI	Wood Powder + HNO_3	Black suspension at top	Turned into yellow color

Conclusion

It was found that different timber wood samples yielded different color due to formation of dissimilar compounds. It proves that chemical test is also an important tool to distinguish or identify the close species of a genus besides anatomical and DNA methods, and it will be helpful to recognize plants for taxonomic identification and illegally traded, exported or smuggled wood samples. We have realized that it would be more effective if we could describe the exact compounds formed after reactions, but it is not an easy task. As far as possible, we will accomplish this task in the second phase of our study.

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